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THE GEOLOGY OF SCOTLAND.

Geological Map of Scotland. By Sir Archibald Geikie, D.Sc., LL.D., F.R.S., Director-General of the Geological Survey of Great Britain and Ireland. With descriptive text. (Edinburgh: J. Bartholomew and Co., 1892.)

THERE have been many attempts to frame a popular definition of man. To call him a "story-loving animal" would not be the worst of them. It may indeed turn out, when we understand monkey-talk a little better than now (and the hope that we may is, we are assured, not unreasonable), then it may be that this will prove to be not an exclusive definition. But this by the way; the description will hold for the present. Hence the delight with which we listen to all that the various branches of history, the history of the growth of knowledge included, have to tell us. It is the stories which first attract us, and they retain their charm long after we have learned that the study of history has other ends to fulfil besides the satisfaction of that craving for story-hearing which lies deep in our being, and the gratification of a natural curiosity to learn about things which we have not seen. But the conviction that history should be to us something more than a string of ancedotes soon forces itself upon us.

In tracing the growth of any branch of knowledge, in noting the steps by which, one by one, each advance has been made good, our interest lies first of all in the acquaintance, almost of a personal character we may say, which we make with the pioneers of a movement of which we see not perhaps the full development but the ripening fruit. We watch with absorbed attention their approach to the unexplored land; we follow them along the tracks by which they first traversed it; we stand by while they note and record all that is novel and characteristic in its features; we mark the birth and growth of the conceptions which their exploring work gives rise to; we live over again their fascinating life of discovery and deduction. But beside and beyond all this, their story, like the stories of all history, carries with it a lesson; and their caution or rashness, as the case may be, in generalizing and drawing conclusions, serves as example or warning to us. We look up to candour and a readiness to court criticism and give up explanations which are shown to be untenable; anything like partizanship and a weakly parental predilection for the children of one's own brain we look down upon with sorrowing pity.

The history of the steps by which a knowledge of the geology of a country has been arrived at is written in the successive versions of its geological maps. The appearance of a map which embodies the results of the latest researches into the geology of Scotland tempts us to look back upon the earlier efforts to unravel the complications of its geological structure. And this all the more because we are dealing with a country in which Geology, as we know it, may be said to have come to the birth; and because it is to Scotchmen that we owe the first showing forth of these principles, whether of observation, deduction, or inductive confirmation, which have been the guide of geologists ever since. To Hutton, the precursor of Lyell, to Hall, the scientific ancestor of Daubrée, and to the line of illustrious followers who have carried on with such brilliant success the work which they started.

Among the earliest attempts to deal with the geological mapping of Scotland are the maps of Macculloch's "Western Islands," which bear the date of 1819. It is hard for us to realize how much of Scotland was at that time without adequate topographical delineation. Our present Ordnance Maps are far from being a credit to the Department which issues them, and the language which attends an attempt to use them on the mountainous moorlands, though not a whit stronger than is justifiable under the circumstances, had better be left to melt into thin air around the spots where it was uttered. But our geological life is one of luxury compared with Macculloch's, whose atlas is one string of apologies for the inadequate maps on which he had to record his observations. The map of the Isle of Man "is obviously very inaccurate, but there was only a choice between it and two others equally unworthy of confidence." The map of Staffa "was drawn under every unfavourable circumstance, and cannot fail to be inaccurate, having been merely paced with the assistance of a pocket compass in a severe gale of wind and rain."

Macculloch seems to have projected, but never completed, a geological map of the whole of Scotland. The materials collected by him were however utilized by the Highland Society in the construction of a general map in 1832.

Passing by the maps of Boué, and a sketch of Murchison's and Sedgwick's, laid before the Geological Society in 1828, we come to the publication of Nicol's "Guide to the Geology of Scotland" in 1844.

In a country where the rocks are so largely unfossiliferous, it is natural, even necessary, that the earliest geological maps should be more of a lithological than a stratigraphical character, and this is the case with the maps so far noticed. In the map which accompanies Nicol's guide, and which he says is based on Macculloch's, some of the main varieties of the crystalline schists are distinguished, but the order in which they occur is not indicated. One colour comprises all the red sandstones, the Torridon, the Old Red, and even the red rocks of Dumfriesshire; under the head of "Porphyry and Trap" are lumped together all the volcanic rocks, including those of the western islands and of the central valley; only two of the groups which we now call formations are separated, the "Carboniferous" and the "Lias and Oolite." But the great leading features in the physical geography of Scotland are sharply marked out, the three regions into which it naturally falls are lucidly delineated, and the work is crowded with local details that betoken acquaintance with the work of others and patient investigation of his own.

At the meeting of the British Association at Glasgow in 1855 Murchison gave an account of the result of the joint work of Nicol and himself in the north western Highlands. The existence of three great sub-divisions had been clearly established; what we now know as the Hebridean or Lewisian Gneiss at the base, the Torridon sandstone resting unconformably on it; while above that, and separated from it by another unconformity, came the limestones and quartzites of Durness and Loch Erriboll, in which Peach had recently discovered fossils. The last group appeared to be conformably overlaid by a great mass of crystalline schists, which came to be known afterwards as the "Upper or Eastern Gneiss." Though the fossil evidence was then incomplete, Murchison saw nothing in it to forbid the belief that the Durness beds were of Lower Silurian age, and his conjecture was confirmed by the discovery of better specimens. This conclusion was announced in a paper read before the Geological Society in 1858, in which it was also stated that the author looked upon the Upper Gneiss as metamorphosed Silurian.

In the meantime Nicol had read a paper before the Geological Society (1856), in which he describes the joint explorations of himself and Murchison, and some subsequent work of his own. He recognizes the same main sub-divisions as Murchison, but still leans to the old notion that the Torridon sandstone belongs to the Old Red; this involves the assigning a later date to the Durness Beds, and these he thinks may be Carboniferous. But he is content to hold this merely as a provisional hypothesis till further fossil evidence is forthcoming. With respect to the Upper Gneiss he is very cautious, suggesting that it may be a newer metamorphic group, or may be merely a portion of the lower, that is Hebridean, gneiss *forced up by some great convulsion*. This latter solution was evidently present very vividly to his mind, for it is repeated, as a possible explanation, no less than three times.

Here a very important difference of opinion between Murchison and Nicol makes its appearance.

It was probably about this time, but the map bears no date, that Nicol issued a new geological map of Scotland. In this all gneiss is denoted by one colour; but the explanation states that the author does not consider all the Scotch gneiss to be of the same age; that the tract of this rock, with associated quartzite and limestone, stretching from Aberdeenshire through Perthshire to the Breadalbane Highlands of Argyllshire, may be a newer formation; while he is disposed to look upon the great mass of gneiss, extending from the north coast of Sutherland southwards through Ross-shire and Inverness-shire, rather as belonging to an older period. The Torridon sandstone is distinguished by a separate colour, though the author is still inclined to class it with the Old Red.

Nicol expounded his views to the British Association at Aberdeen in 1859, and again in a paper read before the Geological Society in 1860. He adduces many reasons for doubting the existence of an "upward conformable succession" from the Durness Beds to the Upper Gneiss, and explains the sections on the supposition that this rock is the Hebridean Gneiss brought up by faults. Though the expressions, "forced up by convulsion" and "pushed up over," which he uses in his paper of 1856, seem to show that the notion of what we call "Thrust Planes" was present to his mind, the sections of this paper hardly bear out that inference. He neatly twits Murchison with failing to see that the principles which he had applied with such success to an explanation of the structure of the Alps were equally applicable to the North-west Highlands. In 1861 Murchison stoutly maintained his view regarding the Upper Gneiss; with an advocate's skill he hits Nicol hard on his weak point, justly urging "that local interferences of eruptive rock nowise set aside broad data." In the same year was issued the "First Sketch of a new geological map of Scotland by Sir R. I. Murchison and A. (now Sir A.) Geikie," in which Murchison's views vere adopted.

Here then was a promise of a fair stand-up fight between two champions, each well able to hold his own. But the promise was not fulfilled. The combat would have been far from equal. On the one side there were the pull which wealth and social position bring with them; the advantage which accrues from living in London and having thus the ear of a great centre of scientific life; and that pushing ambition, that eagerness to secure precedence in discovery, which so often go along with an active and energetic disposition. On the other side there were comparative social insignificance; residence in a hyperborean region far more difficult of access than now; a happy indifference to fame based on a confidence that the settlement might be safely left to time, and that the world would go on pretty much as heretofore, whichever of the two turned out to be nearer the truth: more than all a reluctance to embitter the closing years of life with anything that looked like an altercation with an old and esteemed friend and fellow-worker. So, because it takes two to make a quarrel, the fight never came off. Naturally, under these circumstances, (and can we blame it?) the world took the man who vigorously pushed his views, at his word; he had plenty to say in their favour and said it well; no one gainsaid him; his contention was accepted. There will be those who, without presuming to blame, do not covet success on such terms; and whose sympathies go out towards the peace-loving old man who was content to bide his time and possess his soul in silence.

And so the "Upper Gneiss" and "the upward conformable succession" held their own; and in the geological map of Scotland, issued in 1876 by the present Director-General of the Geological Survey, the crystalline schists of the Central Highlands are designated "Metamorphosed Lower Silurian." It would be tedious to enumerate all the points in which this map is an improvement on the "First Sketch" of 1861, but the student will find it an instructive exercise to compare the two maps, and ascertain by reference to memoirs on special districts how each correction and addition was arrived at.

The Highland problem remained in abeyance for nigh a quarter of a century, though during that interval the minds of many geologists were constantly recurring to it and evidence was being accumulated to help towards its solution. But it came to the front again, and like a giant refreshed with sleep, when Prof. Lapworth in his "Secret of the Highlands" (1883), and other workers in the same ground, began to throw doubt on the explanation which had so long held the field. When the Geological Survey were able to take up the question and work out the ground with precision and detail that no observer could attain to single handed, the anticipations of their immediate predecessors were substantially confirmed, and of the earlier observers it came out that Nicol was nearer the truth than his illustrious antagonist.

It calls for no small exercise of judgment, in an endeavour to depict the geology of so complex a district on a map of small scale, to decide what details must be retained because they are essential to a grasp of its broad general structure, and what may be safely eliminated without impairing the comprehensive view. In the map now before us this end has been compassed with consummate skill. It bristles with detail, but there is nowhere crowding; the colours are well contrasted, and so transparent that they do not hide the topography, which is full and clearly printed.

The richness in detail of the strip of country between Cape Wrath and Loch Torridon marks one scene of the recent work of the Geological Survey. Then follows a broad band of "gneissose and schistose rocks not yet differentiated." A portion of this ground is occupied by the crushed and mangled-out complex of the "Moine schists," but a large part is yet imperfectly explored. To the south-east of the Great Glen we enter again on ground which has been largely worked out by the Geological Survey. We have here a group of various sedimentary deposits in a more or less altered condition, containing sheets of basic igneous rocks. The geological age of this series is not known, and they are provisionally classed as Dalradian.

The presentation of the results of the work of the Geological Survey in the north-west and central Highlands are the two most conspicuous novelties in the map; but during its use other corrections and additions, too small to catch the eye on a general view, become noticeable. In the explanatory notes we have a concise summary of the geology of Scotland, and feel that our thanks are due to the author for having put so much into so small a space without in any way sacrificing descriptive clearness. When the time comes for a new version of the map, may the same hand be with us to draw it up.

A. H. GREEN.

MEDICAL MICROSCOPY.

Medical Microscopy. A Guide to the Use of the Microscope in Medical Practice. By Frank J. Wethered. M.D.(Lond.), &c. With Illustrations. Pp. 412. (London: H. K. Lewis, 1892.)

THIS volume, one of Lewis's practical series, bears an ambitious title, and must necessarily traverse a wide and intricate field of medical work. Its appearance is justified by the distinct need existing at the present time for a manual dealing with the various microscopical methods so essential to diagnostic accuracy and rational treatment.

The subject-matter is arranged in twenty-four chapters; and as an indication of the scope of the book, we instance some of the headings. The earlier ones treat of the microscope and its accessories, the methods of hardening, decalcifying, embedding, section cutting, staining, and injection of tissues. Then follow others on the examination of tissues, urinary deposits, blood, expectoration, and the detection of micro-organisms, and cutaneous parasites; while the latter chapters deal with the examination of food, water, and with bacteriological methods. In fact, the book is almost an epitome of the course pursued by a student earnestly working with the microscope from the commencement to the end of his curriculum. The tendency has been, by the specialized character of the primary examinations in late years, to sever in some degree the knowledge obtained in the earlier part of a student's career from the practical application of the same at the bedside. So much is this the case, that it has been deemed advisable in some quarters to introduce new courses of lectures, their aim being to indicate with precision to students those facts in anatomy and physiology which have a distinct clinical value. One of the chief merits of Dr. Wethered's book is that he has therein demonstrated the important relationship between histology and morbid anatomy, and has shown that any attempt at acquiring a knowledge of the latter is dependent upon a practical and searching training in the former.

Moreover, the book is worthy of more detailed criticism. Necessarily in a first edition there are some points omitted. In speaking of the microscope the author offers a cursory remark on the fine adjustment; no mention is made of the best pattern, and there are many of an inferior and useless description foisted on students; nor are there any directions for the precise use of this portion of the microscope. In the chapter on "Hardening and Decalcifying Tissues," on p. 35, are found some well-meant platitudes on the necessity of immediately labelling specimens; but at the same time the use of lactic acid as a decalcifying agent is omitted. We have succeeded in completely softening small pieces of bone in 4-7 days, and teeth may be cut with the freezing microtome in from two to three weeks.

With certain statements of the author we venture to disagree. In speaking of the celloidin method he advises that the specimen be placed in equal parts of ether and alcohol previously to being placed in celloidin. A mixture of four parts of ether and one part of absolute alcohol ensures more rapid and complete penetration of the embedding material. Also in using paraffin for this purpose we have found by extensive practice that sections containing a large amount of fibrous tissue are useless after being in the paraffin bath for three to five hours, even at a temperature of 48° C.; twenty to thirty minutes is ample, provided that the material is properly dehydrated. The chapter on staining is succinct and comprehensive, and we note the usual and indeed only rational classification of stains, as nuclear, general, and selective. Hæmatoxylin still holds the first place, and Delafield's, or as it is miscalled, Grenacher's, is undoubtedly the best formula. It is here stated that if the sections be overstained, and washing in acid-alcohol be necessary, the colour is not permanent. Our experience is that if after the acid they be washed thoroughly well with "tap water," a very clear nuclear stain results which remains unchanged for years. Gram's method of staining for micro-organisms, with Weigert's modification, is clearly detailed. But here we fail to observe any mention of the brilliant results obtained by the Ehrlich-Biondi method. The employment of rubin for actinomycosis may with confidence be recommended, and the same remark applies to the use of saffranin in bringing out clearly the nuclear figures in karyokinesis. The chapter on mounting is somewhat tedious and the use of origanum oil in clearing celloidin-specimens is not advocated, although it has found general acceptance in Continental laboratories.